U.S. Fish and Wildlife Service

DRAFT ENVIRONMENTAL ASSESSMENT

APPROVAL OF TUNGSTEN-TIN-BISMUTH SHOT FOR HUNTING WATERFOWL AND COOTS

DIVISION OF MIGRATORY BIRD MANAGEMENT

DRAFT ENVIRONMENTAL ASSESSMENT: APPROVAL OF TUNGSTEN-TIN-BISMUTH SHOT AS NONTOXIC FOR HUNTING WATERFOWL AND COOTS

U.S. Fish and Wildlife Service
Division of Migratory Bird Management

JANUARY 2004

ABSTRACT

- In June 2003, Mr. Victor Oltrogge of Arvada, Colorado applied for permanent approval of Silvex metal as a nontoxic shot type. Silvex is composed of tungsten, tin, and bismuth, in proportions ranging from 49 to 71%, 29 to 51%, and 0.5 to 6.5%, respectively. We labeled the submitted shot Tungsten-Tin-Bismuth, or TTB, shot.

- The metals in the shot have already been approved in other shot types in proportions similar to those seen in TTB shot.

- We reviewed the scientific literature and past evaluations of nontoxic shot types containing tungsten, tin, and bismuth to assess the likely effects of approving TTB shot as nontoxic for hunting waterfowl and coots. The data indicate that the shot is nontoxic when ingested by waterfowl, and that it will pose no significant danger to migratory birds, other wildlife, or their habitats. We determined that the shot raises no concerns about deposition in the environment.

- We conclude that TTB shot should be approved for use and that 50 CFR 20.21 should be changed accordingly.

INTRODUCTION

In June 2003, Mr. Victor Oltrogge of Arvada, Colorado applied for permanent approval of Silvex metal as a nontoxic shot type. Silvex is composed of tungsten, tin, and bismuth, in proportions ranging from 49 to 71%, 29 to 51%, and 0.5 to 6.5%, respectively. We labeled the submitted shot Tungsten-Tin-Bismuth, or TTB, shot. Mr. Oltrogge estimated that sales of TTB shotshells might result in annual deposition of 100,000 pounds (45,400 kilograms) of TTB shot in waterfowl hunting areas.

We have reviewed the data on toxicity and environmental fate information for the metals in TTB shot for hunting waterfowl and coots. In this document we review those findings and propose two alternatives for use of the shot.

PURPOSE

The purpose of this assessment is to consider the potential use of the TTB shot for waterfowl hunting. Deposition of shot and release of shot components in waterfowl hunting locations are potentially harmful to many organisms. Since the mid-1970s, we have sought to identify shot that does not pose a significant hazard to migratory birds or other wildlife. Research has shown that ingested spent lead shot causes significant mortality in migratory birds. We first addressed the issue of lead poisoning in waterfowl in a 1976 Environmental Impact Statement, and later readdressed the issue in a 1986 supplemental EIS. The latter provided the scientific justification for a ban on the use of lead shot and the subsequent approval of steel shot for hunting waterfowl and coots that began in 1986, with a complete ban of lead for waterfowl and coot hunting in 1991. Since then, we have considered other shot types for approval as nontoxic. We believe that other nontoxic shot should be made available for public use in hunting.

NEED FOR ACTION

Submission and evaluation of new shot types for approval as nontoxic is given at 50 CFR 20.134. The Fish and Wildlife Service is obligated to consider all such submissions. Steel, bismuth-tin, tungsten-iron, tungsten-polymer, tungsten-matrix, tungsten-nickel-iron, and tungsten-iron-nickel-tin shot are approved as nontoxic for use in hunting migratory birds. Many hunters believe that nontoxic shot does not compare favorably to lead and that it may damage some shotgun barrels, and a small proportion of hunters have not complied with nontoxic shot regulations. Allowing use of additional nontoxic shot types may encourage greater hunter compliance and participation with nontoxic shot requirements and discourage the use of lead shot. Increased use of nontoxic shot will enhance protection of migratory waterfowl and their habitats.

SCOPING AND PUBLIC PARTICIPATION

Under the regulations in 50 CFR 20.134, we are required to respond to applications for approval of new nontoxic shot types. This Draft Environmental Assessment will be published for public comment. We will respond to concerns about the TTB shot expressed in comments.

AUTHORITY AND RESPONSIBILITY

The Migratory Bird Treaty Act of 1918 (MBTA) implements migratory bird treaties between the United States and Great Britain for Canada (1916 and 1996 as amended), Mexico (1936 and 1972 as amended), Japan (1972 and 1974 as amended) and Russia (then the Soviet Union, 1978). They protect all migratory birds covered under any of the four treaties from take except as permitted under the MBTA. The regulatory authority for determining when, where, how, and by whom take of migratory birds can occur in the United States is vested in the Secretary, Department of the Interior. Under 50 CFR Part 20, the Secretary implements regulations for hunting migratory game birds.

BACKGROUND

The requirement to use nontoxic shot for hunting migratory birds created resistance in the hunting community to the use of steel shot, and some noncompliance with the requirement. The use of nontoxic shot for waterfowl hunting has increased in recent years (Anderson *et al*. 2000), but we believe that compliance will continue to increase with the availability and approval of other nontoxic shot types.

On October 24, 2003, we notified the public that Mr. Victor Oltrogge of Arvada, Colorado had applied for approval of Tungsten-Tin-Bismuth shot as nontoxic for waterfowl hunting in the United States, and that the application for approval was complete (68 FR 60898). We reviewed the shot under the criteria in Tier 1 of the revised nontoxic shot approval procedures contained in 50 CFR 20.134 for permanent approval of shot as nontoxic for hunting waterfowl and coots.

AFFECTED ENVIRONMENT

WATERFOWL POPULATIONS

The taxonomic family Anatidae, principally subfamily Anatinae (ducks) and their habitats, comprise the affected environment. Waterfowl habitats and populations in North America this year were described by the U.S. Fish and Wildlife Service (2003a).

In the Breeding Population and Habitat Survey for the traditional waterfowl survey area in North America (strata 1-18, 20-50, and 75-77), the total duck population estimate was 36.2 ± 0.7 (±1 standard error) million birds, 16% above the 2002 estimate of 31.2 ± 0.5 million birds ($P<0.001$), and 9% above the 1955-2002 long-term average ($P<0.001$). There were 7.9 ± 0.3 million mallards (*Anas platyrhynchos*) birds in the traditional survey area, a value similar to the 2002 estimate of 7.5 ± 0.2 million birds ($P=0.220$) and to the long-term average ($P=0.100$). Blue-winged teal (*anas discors*) were at 5.5 ± 0.3 million birds, 31% above the 2002 estimate of 4.2 ± 0.2 million birds ($P=0.001$) and 23% above the long-term average ($P=0.001$). Shovelers (*Anas clypeata*) at 3.6 ± 0.2 million (+56%) and pintails (*Anas acuta*) at 2.6 ± 0.2 million (+43%) were above their 2002 estimates ($P<0.001$). Gadwall (*Anas strepera*) at 2.5 ± 0.2 million, American wigeon (*Anas americana*) at 2.6 ± 0.2 million), green-winged teal (*Anas crecca*) at 2.7 ± 0.2 million, redheads (*Aythya americana*) at 0.6 ± 0.1 million, canvasbacks (*Aythya valisineria*) at 0.6 ± 0.1 million), and scaup (*Aythya marila* and *Aythya affinis*) at 3.7 ± 0.2 million were unchanged from their 2002 estimates ($P=0.149$). Gadwall (+55%) and shovelers (+72%) were above their long-term averages ($P<0.001$). Green-winged teal were at their second highest level since 1955, 46% above their long-term average ($P<0.001$). Pintails (-39%) and scaup (-29%) remained well below their long-term averages ($P<0.001$). American wigeon, redheads, and canvasbacks were unchanged from their long-term averages ($P=0.582$).

The total number of May ponds in Prairie Canada and the north-central U.S., at 5.2 ± 0.2 million, was 91% higher than in 2002 ($P<0.001$) and 7% above the long-term average ($P=0.034$). Canadian and U.S. ponds were 3.5 ± 0.2 and 1.7 ± 0.1 million respectively and both above 2002 (+145% and +30%. $P<0.001$). The number of ponds in Canada was similar to the 1961-2002 average ($P=0.297$), while U.S. ponds were 10% above their 1974-2002 average ($P=0.037$). The projected mallard fall flight index was 10.3 ± 0.9 million birds.

The 2003 total-duck population estimate for the eastern survey area, strata 51-56 and 62-69, was 3.6 ± 0.3 million birds. This was 17% lower than in 2002 (4.4 ± 0.3 million birds, $P=0.065$), but similar to the 1996-2002 average ($P=0.266$). Individual species estimates were similar to those from 2002 and to their 1996-2002 averages, with the exception of mergansers (0.6 ± 0.1 million), which decreased 30% from the 2002 estimate ($P=0.035$).

HABITATS

Waterfowl hunting occurs in habitats used by many taxa of migratory birds, as well as by aquatic invertebrates, amphibians and some mammals. Fish also may be found in many hunting locations.

ALTERNATIVES

Alternative 1: No Action. We would not authorize the use of TTB shot as nontoxic for hunting waterfowl and coots. This alternative would maintain the status quo by limiting the shot available to the hunting public to those currently approved for waterfowl hunting.

Alternative 2: Approval of TTB shot as nontoxic. This is the proposed action. We would approve TTB shot as nontoxic. Our approval would be based on the information in the application and on toxicological reports, acute toxicity studies, reproductive/chronic toxicity studies, and other published research. The available information indicates that TTB shot is nontoxic when ingested by waterfowl and that it poses no significant danger to migratory birds, other wildlife, or their habitats.

CHARACTERIZATION OF TUNGSTEN-TIN-BISMUTH SHOT

Tungsten-Tin-Bismuth shot is an alloy of 49% to 71% tungsten, 29% to 51% tin, and 0.5% to 6.5% bismuth; the composition of the alloy is varied according to its intended purpose. The sectional density of TTB ranges from 10.5 to 13.0 grams/cm^3. The shot has no coating. It is not chemically or physically altered by firing from a shotgun. Neither manufacturing the shot nor firing shotshells containing the shot will alter the metals or increase their susceptibility to dissolving in the environment.

ESTIMATED ENVIRONMENTAL CONCENTRATIONS FOR TUNGSTEN-TIN-BISMUTH SHOT

TERRESTRIAL ECOSYSTEM

Calculation of the estimated environmental concentration (EEC) of a candidate shot in a terrestrial ecosystem is based on 69,000 shot per hectare (50 CFR 20.134). For TTB shot, if the shot are completely dissolved, the EEC for tungsten in soil is 10.1 to 18.5 mg/kg. This is considerably smaller than the 50 mg/kg suggested maximum concentration in surface soil tolerated by plants (Kabata-Pendias and Pendias 2001). The EEC for tungsten from TTB shot is below that for tungsten-matrix shot. Tungsten is very rare, and is never found free in nature. The tungsten concentration in the earth's crust is estimated to be 1.5 parts per million.

The EEC for tin is 6.8 to 10.5 mg/kg. Tin occurs naturally in soils at 2 to 200 mg/g with areas of enrichment at much higher concentrations (up to 1000mg/g) (WHO 1980). However, in the United States, soil concentrations are between 1 and 5 mg/kg (Kabata-Pendias and Pendias 2001).

The EEC for bismuth in soil is 0.13 mg/kg to 1.28 mg/kg, depending on the shot formulation. Bismuth is rare in soils and sediments; is comprises about 0.00002% of the earth's crust.

AQUATIC ECOSYSTEM

The EEC for water assumes that 69,000 #4 shot are completely dissolved in 1 hectare of water 1 foot (30.48 cm) deep. For TTB shot, the EEC for tungsten is 2.2 to 3.9 mg/l. The EEC value for tin in an aquatic setting ranges from 1.4 to 2.2 mg/l. We found no EPA aquatic criterion for elemental tin. The EEC for bismuth in an aquatic setting is 28 to 274 μg/l.

ENVIRONMENTAL CONSEQUENCES OF THE ALTERNATIVES

ENVIRONMENTAL FATE

Elemental tungsten is virtually insoluble in water, and therefore does not weather and degrade in the environment. Tungsten is stable in acids and does not easily form compounds with other substances. Preferential uptake by plants in acidic soil suggests uptake of tungsten when it has formed compounds with other substances rather than when it is in its elemental form (Kabata-Pendias and Pendias 1984). In water, tin is stable under ambient conditions.
Bismuth

TOXICOLOGICAL EFFECTS OF TUNGSTEN-TIN-BISMUTH SHOT

MAMMALS

Tungsten. Tungsten may be substituted for molybdenum in enzymes in mammals. Ingested tungsten salts reduce growth, and can cause diarrhea, coma, and death in mammals (*e.g.* Bursian *et al*. 1996, Cohen *et al*. 1973, Karantassis 1924, Kinard and Van de Erve 1941, National Research Council 1980, Pham-Huu-Chanh 1965), but elemental tungsten is virtually insoluble and therefore essentially nontoxic. Tungsten powder added to the food of young rats at 2, 5, and 10% by mass for 70 days did not affect health or growth (Sax and Lewis 1989). A dietary concentration of 94 parts-per-million (ppm) did not reduce weight gain in growing rats (Wei *et al*. 1987). Exposure to pure tungsten through oral, inhalation, or dermal pathways is not reported to cause any health effects (Sittig 1991).

Tungsten salts are toxic to mammals. Lifetime exposure to 5 ppm tungsten as sodium tungstate in drinking water produced no discernible adverse effects in rats (Schroeder and Mitchener 1975). At 100 ppm tungsten as sodium tungstate in drinking water, rats had decreased enzyme activity after 21 days (Cohen *et al*. 1973).

Kraabel *et al*. (1996) surgically embedded tungsten-bismuth-tin shot in the pectoralis muscles of ducks to simulate wounding by gunfire and to test for toxic effects of the shot. The authors

found that the shot neither produced toxic effects nor induced adverse systemic effects in the ducks during the 8-week period of their study.

Tin. Inorganic tin compounds are comparatively harmless; inorganic tin and its salts are poorly absorbed, their oxides are relatively insoluble, and they are rapidly lost from tissues (see Eisler 1989 for reviews).

Bismuth. Bismuth is very rarely found in nature; it is almost always found in ores with other metals. There is very limited information on bismuth effects in animals, and we found no information indicating that bismuth is toxic to mammals.

BIRDS

Tungsten. Chickens given a complete diet showed no adverse effects of 250 ppm sodium tungstate administered for 10 days in the diet. However, 500 ppm in the diet reduced xanthine oxidase activity and reduced growth of day-old chicks (Teekell and Watts 1959). Adult hens had reduced egg production and egg weight on a diet containing 1,000 ppm tungsten (Nell *et al*. 1981). Ecological Planning and Toxicology (1999) concluded that the No Observed Adverse Effect Level for tungsten for chickens should be 250 ppm in the diet; the Lowest Observed Adverse Effect Level should be 500 ppm. Kelly *et al*. (1998) demonstrated no adverse effects on mallards dosed with tungsten-iron or tungsten-polymer shot according to nontoxic shot test protocols.

Tin. Reviews indicate that elemental tin is not toxic to birds (Cooney 1988, Eisler1989). Tin shot designed for waterfowl hunting is used in several European countries. We are aware of no reports that suggest that tin shot causes toxicity problems for wildlife.

Grandy *et al*. (1968) and the Huntingdon Research Centre (1987) conducted 30-day and 28-day, respectively, acute toxicity tests on mallard ducks by placing tin pellets inside the digestive tract or tissues of ducks. They reported that all treated ducks survived without deleterious effects.

Ringelman *et al*. (1993) conducted a 32-day acute toxicity study which involved dosing game-farm mallards with a shot alloy of 39% tungsten, 44.5% bismuth, and 16.5% tin (TBT shot) by weight, respectively. All the test birds survived and showed normal behavior. They suffered no tissue toxicity or damage.

As noted for tungsten, Kraabel *et al*. (1996) imbedded TBT shot in muscles of ducks for an 8-week study. They determined that the shot neither produced toxic effects nor induced any adverse systemic effects on the health of the ducks.

The 2% tin in bismuth-tin (BT) shot produced no toxicological effects in ducks during reproduction. It did not affect the health of ducks, the reproduction by male and female birds, or the survival of ducklings over the long term (Sanderson *et al*. 1997).

In a 30-day dosing study using game-farm mallards dosed with eight #4 size tin shot, there were no overt signs of toxicity or treatment-related effects on body weight. Tin was not detected in any tissues (Gallagher *et al.* 1999).

Based on the toxicological report and the toxicity tests for tin shot, we concluded that tin shot, which was approximately 99.9 percent tin by weight, posed no significant danger to migratory birds or other wildlife and their habitats (Federal Register 65 (236):76885-76888). We believe the tin in TTB shot will not harm waterfowl or any other segment of the environment.

Bismuth. Sanderson et al. (1992, 1994) and Ringelman *et al.* (1992) saw no adverse effects when bismuth alloy shot was ingested by captive-reared mallards. In Grandy et al. (1968), there were no deaths associated with mallards dosed with tin shot.

The 30-day acute toxicity test conducted for approval of bismuth-tin shot in 1996 (61 FR 42491-42494) demonstrated that survival to 30 days post dosing, hematocrit values, body weight, mean weight of kidney, liver, gonad, and gizzard were similar in game-farm mallards dosed with either six No. 4 bismuth-tin shot, six No. 4 steel shot, or a placebo (Sanderson et al. 1995). The 14-week chronic toxicity test for approval of bismuth-tin shot documented that the shot had no deleterious effects on captive-reared mallards (Sanderson et al. 1997). There were no significant differences in the time required for laying of 21 eggs and no differences in the dates when the dosed and control groups began to lay. Similarly, there were no significant differences among doses in the fertility rates, hatchability rates, or chemical content of the eggs. In ducklings, no significant differences among doses in the mean body weight (by day 7), sex ratios, hematocrit, mean weights of kidney and liver, mean amounts of elements in organs, or in the histopathology results arose(Sanderson et al. 1996).

With approval of bismuth-tin shot in 1996, the Service concluded that shot composed of 97% bismuth and 3% tin posed no significant danger to migratory birds and other wildlife and their habitats. We have no reason to believe otherwise at this time. We do not believe the lower concentration of bismuth in TTB shot will have deleterious effects on the environment.

OTHER ENVIRONMENTAL ISSUES

We have previously permanently or temporarily approved as nontoxic other shot types that contain tungsten, tin, and bismuth. Previous assessments of tungsten-iron, tungsten-polymer, tungsten-matrix, and tungsten-nickel-iron shot indicated that the tungsten, tin, and bismuth in TTB shot should be of concern in aquatic or terrestrial systems. It is generally agreed that inorganic tin and tin compounds are comparatively harmless (Eisler 1989). Reviews of past studies for approvals of other tungsten-based nontoxic shot types also support the idea that ingestion of TTB shot will not cause harm to birds or mammals. We have no concerns about approving an additional shot that contains these metals.

IMPACTS OF THE "NO ACTION" ALTERNATIVE

Migratory Waterfowl. The status quo would be maintained by not authorizing use of TTB shot for hunting waterfowl and coots. By regulation, steel, bismuth-tin, tungsten-iron, tungsten-polymer, tungsten-matrix, tungsten-nickel-iron, and tungsten-iron-nickel-tin are the only nontoxic shot types authorized for use by waterfowl and coot hunters. Because these shot types have been shown to be nontoxic to migratory birds, using only those shot types would have no adverse impact on waterfowl and their habitats. Test results on the toxicity of TTB shot and analyses of its likely effects on migratory birds indicate that it too is nontoxic. We are concerned, however, because some nontoxic shot types are not widely used, and steel is unacceptable to a percentage of waterfowl hunters. Without alternative nontoxic shot types, hunters may not comply with the requirement for use of nontoxic shot when hunting waterfowl. The hunters who still consider steel an unacceptable alternative might continue to use lead, resulting in a small negative impact to the migratory bird resource. Use of lead shot would also negatively impact wetland habitats because of shot erosion and the ingestion of shot by aquatic animals. We are concerned about noncompliance, but we believe that the no action alternative would have only a small negative impact on the resource.

Endangered and Threatened Species. The impact on endangered and threatened species of "no action" should be minimal. We obtain a biological opinion pursuant to Section 7 of the Endangered Species Act prior to establishing the seasonal hunting regulations. The hunting regulations promulgated as a result of this consultation remove and alleviate chances of conflict between migratory bird hunting and endangered and threatened species. We also will consult on effects on threatened and endangered species concurrent with the approval of TTB shot.

Our consultations do not address take resulting from noncompliance. Indeed, a factor considered when we developed the regulations banning the use of lead for migratory waterfowl hunting was the impact of lead on endangered and threatened species. Hunter failures to comply with the existing ban on lead are of concern to us. If additional alternatives to lead shot are not available, small amounts of lead shot may be added to the environment, causing a negative impact on endangered and threatened species. We believe noncompliance is of concern, but the "no action" alternative would have only a small negative impact on the resource.

Ecosystems. Steel, bismuth-tin, tungsten-iron, tungsten-polymer, tungsten-matrix, tungsten-nickel-iron, and tungsten-iron-nickel-tin nontoxic shot types are permanently authorized for use by waterfowl and coot hunters. Because those shot types have been shown in test results to be nontoxic to the migratory bird resource, we assume that they cause no adverse impact on ecosystems. There is concern, however, about noncompliance and potential ecosystem effects. The use of lead shot has a negative impact on wetland ecosystems due to the erosion of shot, causing sediment/soil and water contamination and the direct ingestion of shot by

aquatic and predatory animals. Though we believe noncompliance is of concern, the "no action" alternative would continue to have only a small negative impact on the resource.

Socioeconomic Issues. In the 2002-2003 hunting season there were approximately 1.38 million active waterfowl hunters (U.S. Fish and Wildlife Service 2003b). There is concern that a small percentage of this hunting public finds some nontoxic shot to be unacceptable, but also ceased using lead when they became aware of its toxic properties. Factors unrelated to the availability of nontoxic shot (such as framework regulations, hunting success, availability of birds, hunting sites, weather, and habitat) probably have a much greater impact on hunter participation, and therefore on the socioeconomic environment. Capital expenditures (such as purchases of shotguns) likely are more affected by hunter numbers. The alternative of "no action" would contribute to fewer numbers of hunters and result in less financial support for hunting-supported retail businesses and less money available to public management programs. This is a minor negative impact on socioeconomic conditions.

The "no action" alternative would have a major negative impact on those who invested in the development and marketing of TTB shot. In isolated instances this impact would be major, but to the overall migratory bird hunting culture, impact would be minor. Total economic value of waterfowl hunting only represents a negligible portion of the national product. Also, if a shot material is considered with some level of confidence to be nontoxic and otherwise not a danger to the environment, non-approval would have a negative socioeconomic impact by restricting the development of new businesses and markets.

IMPACTS OF APPROVAL OF TUNGSTEN-TIN-BISMUTH SHOT AS NONTOXIC

Migratory Waterfowl. Furnishing another approved nontoxic shot will likely result in a minor positive long-term impact on waterfowl and wetland habitats. Approval of TTB shot as nontoxic would have a positive impact on the waterfowl resource.

Endangered and Threatened Species. The impact of this alternative on endangered and threatened species is similar to that described for waterfowl. In the short- and long-term, this alternative would provide a positive impact on endangered and threatened species by assuring that TTB shot has been found nontoxic. Also, as an alternative shot, it will further discourage the use of lead during waterfowl hunting and perhaps extend to upland game.

Ecosystems. Approval of TTB shot as nontoxic would have a short-term positive impact on ecosystems. Some hunters still shooting lead shot may switch to TTB shot. Approval of an additional nontoxic shot type will result in positive long-term impact on ecosystems.

Socioeconomic Issues. In the short- and long-term, a minor positive impact will result by approving TTB shot as an alternative to other approved nontoxic shot types. People who may

have stopped hunting might be encouraged to participate again, and businesses could experience increased activity. Funding support for public programs will increase and product manufacturers will be able to target potential markets.

COMPARISON OF EFFECTS

Impacts	Alternative 1	Alternative 2
Migratory Waterfowl	No Impact	Minor Short- and Long-term Positive Impacts
Endangered and Threatened Species	No Impact	Minor Short- and Long- term Positive Impacts
Socio/Economic	No Impact	Minor Short- and Long-term Positive Impacts

CUMULATIVE IMPACTS

We foresee no negative cumulative impacts of approval of TTB shot for waterfowl hunting. Approval of an additional nontoxic shot type should help to further reduce the negative impacts of the use of lead shot for hunting waterfowl and coots.

TRANS-BOUNDARY EFFECTS

We believe the impacts of approval of TTB shot for waterfowl hunting should be positive both in the United States and elsewhere. Approval of an additional nontoxic shot type should help to further reduce lead poisoning of waterfowl that migrate south of the U.S. for the winter and of animals that prey on them or consume their carcasses.

CONSULTATION, COORDINATION, AND COMMENTS

We will make this Environmental Assessment available for public comment for 15 days. We will respond to all agency and private comments on the proposal to approve TTB shot as nontoxic for hunting waterfowl.

Preparers

This document was prepared by John Kreilich, Jr. and George T. Allen, Ph.D., of the Division of Migratory Bird Management. Mr. Kreilich is a wildlife biologist with additional background in business. Dr. Allen has approximately 20 years experience in wildlife research and management. He is a Certified Wildlife Biologist.

LITERATURE CITED

Anderson, W. L., S. P. Havera, and B. W. Zercher. 2000. Ingestion of lead and nontoxic shotgun pellets by ducks in the Mississippi flyway. Journal of Wildlife Management 64:848-857.

Bursian, S. J., M. E. Kelly, R. J. Aulerich, D. C. Powell, and S. Fitzgerald. 1996. Thirty-day dosing test to assess the toxicity of tungsten-polymer shot in game-farm mallards. Report to Federal Cartridge Company.

Cohen, H. J., R. T. Drew, J. L. Johnson, and K. V. Rajagopalan. 1973. Molecular basis of the biological function of molybdenum: the relationship between sulfite oxidase and the acute toxicity of bisulfate and SO_2. Proceedings of the National Academy of Sciences 70:3655-3659.

Cooney, J. J. 1988. Microbial transformations of tin and tin compounds. Journal of Industrial Microbiology 3:195-204.

Ecological Planning and Toxicology, Inc. 1999. Application for approval of Hevi-metal™ nontoxic shot: Tier 1 report. Cherry Hill, New Jersey.

Eisler, R. 1989. Tin hazards to fish, wildlife and invertebrates: a synoptic review. Biological report 85(1.15), U.S. Fish and Wildlife Service, Washington, D.C.

Gallagher, S. P., J. B. Beavers, R. Van Hoven, and M. Jaber. 1999. Pure tin shot: a chronic exposure study with the mallard, including reproductive parameters. Project Number 475-102. Wildlife International Ltd., Easton, Maryland.

Grandy, J. W., L. N. Locke, and G. E. Bagley. 1968. Relative toxicity of lead and five proposed substitute shot types to pen-reared mallards. Journal of Wildlife Management 32:483-488.

Huntingdon Research Centre Ltd. 1987. The effects of dosing mallard ducks with Safe Shot. Huntingdon, Cambridge, U.K. Report dated Dec. 19, 1987.

Kabata-Pendias, A. and H. Pendias. 1984. Trace elements in soils and plants. CRC Press, Inc. Boca Raton, FL.

Karantassis, T. 1924. On the toxicity of compounds of tungsten and molybdenum. Annals of Medicine 28:1541-1543.

Kelly, M. E., S. D. Fitzgerald, R. J. Aulerich, R. J. Balander, D. C. Powell, R. L. Stickle. W. Stevens, C. Cray, R. J. Tempelman, and S. J. Bursian. 1998. Acute effects of lead, steel, tungsten-iron and tungsten-polymer shot administered to game-farm mallards. Journal of Wildlife Diseases 34:673-687.

Kinard, F. W. and J. Van de Erve. 1941. The toxicity of orally-ingested tungsten compounds in the rat. Journal of Pharmacology and Experimental Therapeutics 72:196-201.

Kraabel, F. W., M. W. Miller, D. M. Getzy, and J. K. Ringleman. 1996. Effects of embedded tungsten-bismuth-tin shot and steel shot on mallards. Journal of Wildlife Diseases 38:1-8.

National Research Council. 1980. Mineral tolerance of domestic animals. National Research Council, National Academy of Sciences, Washington, D.C.

Nell, J. A., W. L. Bryden, G. S. Heard, and D. Balnave. 1981. Reproductive performance of laying hens fed tungsten. Poultry Science 60:257-258.

Pham-Huu-Chanh. 1965. The comparative toxicity of sodium chromate, molybdate, tungstate, and metavanadate. Archives Internationales de Pharmacodynamie et de Therapie 154:243-249.

Ringelman, J. K., M. W. Miller, and W. F. Andelt. 1993. Effects of ingested tungsten-bismuth-tin shot on captive mallards. Journal of Wildlife Management 57:725-732.

Sanderson, G.C., S.G. Wood, G.L. Foley and J.D. Brawn. 1992. Toxicity of bismuth shot compared with lead and steel shot in game-farm mallards. Trans. 57th N.A. Wildl. Nat. Res. Conf., 57:526-540.

Sanderson, G.C., W.L. Anderson, G.L. Foley, L.M. Skowron and J.W. Seets. 1994. Toxicity and reproductive effects of ingested bismuth alloy shot and effects of embedded bismuth alloy, lead, and iron shot on game-farm mallards. Final Report. Ill. Nat. Hist Survey. Champaign, Illlinois.

Sanderson, G.C., W.L. Anderson, G.L. Foley, L.M. Skowron, J.D. Brawn and J.W. Seets. 1995. Toxicity of ingested bismuth alloy shot on game-farm mallards (Revised Final Report). Report to Peterson Publishing Company by the Univ. of Illinois, Ill. Nat. Hist. Survey. Champaign, IL. 69pp.

Sanderson, G. C., W. L. Anderson, G. L. Foley, K. L. Duncan, L. M. Skowron, J. D. Brawn, and J. W. Seets. 1997. Toxicity of ingested bismuth alloy shot in game farm mallards: chronic health effects and effects on reproduction. Illinois Natural History Survey Bulletin 35:217-252.

Sax, N. I, and R. J. Lewis, 1989. Copper compounds. *In* dangerous properties of industrial metals. Volume II. Seventh edition. Van Nostrand Reinhold, New York.

Schroeder, H. A. and M. Mitchener. 1975. Life-term studies in rats: effects of aluminum, barium, beryllium, and tungsten. Journal of Nutrition 105:421-427.

Sittig, M. 1991. Handbook of toxic and hazardous chemicals and carcinogens. Volume II. Third edition. Noyes Publications, Park Ridge, New Jersey.

Teekel, R. A. and A. B. Watts. 1959. Tungsten supplementation of breeder hens. Poultry Science 38:791-794.

U.S. Fish and Wildlife Service. 2003a. Waterfowl population status, 2003. U.S. Fish and Wildlife Service, Washington, D.C.

U.S. Fish and Wildlife Service. 2003b. Preliminary estimates of waterfowl hunter activity and harvest during the 2001 and 2002 hunting seasons. Administrative Report, U.S. Fish and Wildlife Service, Washington, D.C.

Weast. R.C. , Editor. 1986. CRC handbook of chemistry and physics, 67th edition. CRC Press, Inc., Boca Raton, Florida.

Wei, H. J., X-M. Luo, and X-P. Yand. 1987. Effects of molybdenum and tungsten on mammary carcinogenesis in Sprague-Dawley (SD) rats. Chung Hua Chung Liu Tsa Chih 9:204-7. English abstract.

DIVISION OF MIGRATORY BIRD MANAGEMENT